Chapter 20

Farm to Table Blockchain in Agricultural Supply Chains

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Abstract

Production, preparation, delivery, and shipping are all influenced by the growing inter-connectivity of agri-food supply chains. However, fraudulent conduct attracts attention to deficiencies in accountability, leading to monetary losses, concerns with customer confidence, and a decline in the worth of an organization's reputation. Blockchain technology has the potential for boosting transparency in international agricultural supply chains, thus mitigating concerns regarding fraudulent activities and advancing impartial, sustainable, and secure food production techniques. Supply chains have transformed into autonomous networks that promote food quality and benefit consumers. Assuring data transparency remains challenging, though. A potential remedy addresses vulnerabilities with product traceability, credibility, and transparency in the agriculture and food supply chains by utilizing blockchain technology and Ethereum smart contracts. The study emphasizes the restricted application of blockchain technology in real-world scenarios and the significance of a reliable agricultural traceability system to address perilous practices like the usage of pesticides and fertilizers. By eliminating mediators and centralized control, a blockchain-based agricultural supply chain optimizes security and productivity. While Agriculture, Blockchain, and Internet of Things (IoT) (Agri-Block-IoT) integrates data from IoT devices to ensure honesty, transparency, and confidentiality in the supply chain network, smart contracts coordinate communications and transactions. The present study explores the utilization of blockchain technologies to augment traceability within the agri-food industry, overcoming constraints in the management of the intricate agricultural supply chain. Examining current initiatives and challenges, the paper explores the integration of blockchain technology in food supply chains and agriculture. There are still impediments in the process of its widespread adoption by farmers and systems, despite its potential for transparency.

Keywords

Agri-Block-Iot, Agricultural Traceability, Farm-To-Fork Food Safety, Food Security

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1. Introduction

To guarantee food safety as well as minimize the likelihood of infections from negligence or inadequate hygiene during the preparation and storage stages, smart agriculture employs an effective, hygienic and reliable food supply chain system [1]. The development of trustworthy, auditable, and transparent traceability systems utilizing distributed ledger technology is imperative considering the swiftly changing food and agriculture supply chains triggered by Internet of Things (IoT) [2]. Farmers struggle with data collecting, retention, safety, and transmission as they attempt to meet increasing production demands while maintaining sustainability. Complicating matters are climate change, increasing input costs, and energy shortages. Nowadays, one source of breakdown and data security is ignored in favor of centralized IoT-based agricultural platforms [3]. By tracking food itineraries using blockchain technology, a new agri-food supply chain traceability system assures product quality and safety. Utilizing an agile methodology, the system was designed with the Hyperledger Sawtooth blockchain, facilitating autonomous management of chronological actions and easy identification of participating parties for stakeholders [4]. Blockchain, IoT, wireless sensor networks, cloud computing, and machine learning are all being integrated by ICT to transform digital agriculture. There is, however, an absence of research on the variables impacting supply chain participants' ICT adoption [5]. Farm-to-fork food safety and quality certification have become very important. Increasing threats to food security and contamination have led to the enormous need for a revolutionary traceability system, an important mechanism for quality control that ensures sufficient food supply chain product safety [6]. By establishing data security and traceability, blockchain technology solves issues affecting agricultural food supply networks. The Inter-Planetary File System (IPFS) is employed by farmers to store encrypted files in digital contracts, record environmental information, and monitor agricultural growth. This improves data security and minimizes storage challenges [7]. Traditional food supply chains have drawbacks, such as ineffective distribution networks and fraudsters tracking down production and processing. By facilitating immutable and dependable technology, facilitating open communication, and ensuring cultivators receive equitable payment, blockchain technology can assist in resolving such issues [8].

2. Blockchain Integrated Agri-Food Supply chain

Traceability in food supply chains is demanded by agricultural frauds, but traditional solutions confront adoption costs and security concerns. Blockchain technology has the potential to resolve these problems and improve management and quality control [9]. Blockchain technology has the potential address issues with fraud, supply chain transparency in agri-food supply chains, brand value deterioration, adverse financial impacts, and compromised consumer confidence [10]. Supply chains are transforming into automated infrastructure, which has advantages but also presents complications for traceability and data origin tracking. Although Ethereum blockchain and smart contracts are employed in a blockchain-based agriculture and food solution, conventional supply chains still lack accountability, transparency, and predictability [11]. The increased attention on food safety and corruption as a result of globalized industry and agricultural production has made robust traceability systems imperative. To authenticate requirements such as the country of origin, crop development stages, and quality regulations, blockchain presents an innovative approach for traceability in these intricate ecosystems [12]. By resolving credibility challenges, blockchain technology is transforming the effectiveness of supply chains. It is anticipated to enhance schedules, interruptions, and intermediaries in sustainable agriculture supply chains (ASC) [13]. By leveraging blockchain technology, the suggested approach eliminates the necessity for agents and

centralization by establishing an open platform for cooperative farming. Traceability is accessible via Agri-Block-IoT, while smart contracts manage transactions and connectivity [14]. Blockchains are critical for agriculture since they deliver supply chain management and food origin supervision. They offer enhanced safety, rendering data impenetrable. Agri-business operations can operate more efficiently due to the real-time updates on the quality of goods and transit time that IoT devices, including smartphone apps, provides [15]. Examining blockchain's potential use in agriculture, specifically focusing on issues related to food traceability and potential difficulties arising from the heavy application of pesticides and fertilizers [16]. Despite the need for additional scale and adoption, NFC and RFID technologies are promoting sustainability and transparency in agri-food supply chains, strengthening customer trust, and ensuring accountability [17]. Automation and IoT technologies, such as barcodes, QR codes, RFID, and wireless sensor networks, create effective transparency and traceability solutions imperative due to the complexity of agricultural supply chain management [18]. With its capacity to link untrusted nodes in intricate food supply chains and guarantee protocol adherence, blockchain technology offers integrity and dependability [19].

3. Recommendations

Based on the literature review conducted for this study, we propose following recommendations for improved agri-food supply chain.

- An integrated assessment of blockchain's performance in delivering cost-effectiveness, scalability, and efficiency when paired with cutting-edge technologies like IoT, AI, big data, and cloud computing has been missing from currently available studies.
- Blockchain technology eliminates challenges with agricultural data tracking through streamlining supply chain management in agriculture by facilitating peer-to-peer transactions directly without the need for intermediaries or financial institutions.
- Subsequent studies should investigate the regulations and standards pertaining to the agriculture industry, prioritizing stakeholder participation while carefully analyzing government roles in enforcing consistent standards throughout the supply chain.
- In order to facilitate the seamless integration of dispersed technologies, a new agricultural supply chain architecture must guarantee interoperability, scalability, security, privacy of personal data, and ease storage problems.
- In the agricultural supply chain, a shortage of information security and confidentiality has a detrimental effect on data transmission accuracy and discourages stakeholder transparency.
- Future studies should concentrate on empirical assessments of blockchain's effectiveness in real-time agri-food supply chains, with a particular emphasis on properties such as the source, accountability traceability, and immutability.

Conclusion

According to the literature review, there are still many unexplored blockchain, artificial intelligence, and IoT applications in agriculture, with very few real systems being created and put into place. To assess their possible advantages, real-time applications are required. This literature review explores blockchain technology's potential in the agricultural sector, focusing on food traceability issues, identifying current trends, challenges, and unresolved research questions. With the use of blockchain technology, a

self-governing, transparent smart farming network involving all parties involved can be established. Agri-Block-IoT eliminates middlemen by fusing blockchain technology with IoT to monitor and create traceability for transactions throughout the agricultural supply chain. Blockchains and Industry 4.0 advancements are enhancing agricultural and food supply chain agility. However, challenges like disparities in digital infrastructure, awareness, and human resource capabilities need to be addressed to ensure widespread adoption.

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